AN ANALYSIS OF NEST BOX USE BY PURPLE MARTINS, HOUSE SPARROWS, AND STARLINGS IN EASTERN NORTH AMERICA

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In eastern North America the Purple Martin (*Progne subis*) now nests almost exclusively in houses provided by man. Recognizing this dependency on and popularity with man, Jackson initiated a survey of martin populations in Mississippi in 1971. The purposes of the survey were to monitor population fluctuations of the species over a period of years and to determine the habitat characteristics that favor a successful martin colony. The survey met with such overwhelming response from the general public that it was soon expanded to include all of eastern North America. The questionnaires that were distributed also asked for information relating to the population biology of other hole-nesting species, particularly House Sparrows (*Passer domesticus*) and Starlings (*Sturnus vulgaris*), that compete with martins for nest sites. This paper is an analysis of the response of volunteer cooperators to two questionnaires that were distributed for the 1971 breeding season. The previous published surveys of Purple Martin populations by Bartel (1947, 1959), Mayfield (1964, 1969), and Hunter (1967) were on a smaller scale within small geographic areas, and they considered population numbers without regard for nest site characteristics.

THE QUESTIONNAIRE AND ANALYSIS

The initial single page questionnaire included the following questions:

1. We have (*number*) martin house(s) and (*number*) gourds for martins. These provide a total of (*number*) nest compartments.
2. At the present time (*day month year*) we have the following actual or approximate number of individuals occupying our nest compartments: Purple Martins (*number*), House Sparrows (*number*), Starlings (*number*), Other (Specify) (*number*).
3. Our martin house and/or gourds are approximately (*number*) feet above the ground.
4. The area immediately surrounding our martin house and/or gourds (within about 50 ft.) (Circle one): 1) is a lawn or pasture with few small shrubs; 2) is a lawn or pasture with one or more small trees; 3) is a lawn or pasture with one or more large trees; 4) Other (Specify).
5. Our martin house and/or gourds are approximately (*number*) feet from the nearest building.

This questionnaire was freely distributed to any potential respondent, and was completed by 1067 persons from 32 states, the District of Columbia, and five Canadian provinces. These areas and numbers of respondents were as follows: Alabama (5), Arkansas (47), Connecticut (8), Delaware (1), District of Columbia (2), Florida (12), Georgia (1), Illinois (16), Indiana (3), Iowa (108), Kansas (2), Louisiana (8), Maine

(12), Maryland (11), Massachusetts (1), Michigan (11), Minnesota (18), Mississippi (592), Missouri (4), Nebraska (5), New Hampshire (1), New Jersey (14), New York (77), North Dakota (1), Ohio (10), Oklahoma (12), Pennsylvania (26), Rhode Island (1), South Carolina (7), Tennessee (9), Texas (5), Virginia (8), Wisconsin (8), Alberta (4), Manitoba (1), Nova Scotia (1), Ontario (12), Quebec (3).

The phraseology of our question relating to the number of birds using the apartments resulted in some misinterpretation and inconsistent data. We asked for the number of each species using the apartments, so that at times nestlings as well as adults were counted. Where this was apparent, these data were questioned and corrected or discarded.

For the purpose of this study, the word colony is used to refer to all of the apartments supplied by one respondent at one locality. A colony may include one or more apartment house and/or gourds. An apartment is defined as a single potential nest site, whether it is a separate unit, such as a gourd, or part of a multiple unit structure (i.e., an apartment house).

Using the data from the first questionnaire, we calculated the ratios of martins, sparrows, and Starlings per apartment. In addition, some comparisons of martin and sparrow populations and the relative use by the birds of apartments in houses and gourds in Mississippi were possible because of the large number of cooperators from that state. These ratios were compared for different geographic areas, and for differences in apartment heights, distance of apartments from the nearest building, and immediate environment of the apartments.

The second questionnaire, sent to respondents to the first, consisted of three pages relating to apartment characteristics, colony history, habitat, apartment maintenance, and apartment use by the birds. Only data for apartment houses ($N = 622$) are included here in our analysis of the second questionnaire data. Separate questionnaires were completed for each multiple-apartment house. Questions regarding the characteristics and location of the house included the following:

1. We have (*number*) multiple-apartment houses and (*number*) single-apartment houses or gourds.
2. The multiple-apartment house here described was first erected on the present site in (*year*).
3. There are other martin colonies within one-half mile of this one. 1. Yes 2. No.
4. This house is 1. Aluminum 2. Wood 3. Plastic 4. Fiberglass 5. Ceramic 6. Other.
5. The outside of this house is basically 1. White 2. Green 3. Brown 4. Red 5. Blue 6. Other.
6. The inside of the apartments is basically 1. White 2. Green 3. Brown 4. Other.
7. This house is in the shade 1. Only in early morning 2. Most of the morning 3. Most of the day 4. Most of the afternoon 5. Only in late afternoon 6. All of the day 7. Never in the shade 8. Other.
8. The location of this house can best be described as 1. Urban, business, or industrial area 2. Urban, residential area 3. Suburban 4. Rural 5. Other.
9. There is a lake, pond, stream, or river that can be seen from the martin house. 1. Yes 2. No.
10. There are power or telephone lines that can be seen from the martin house. 1. Yes 2. No.
11. We clean the apartments out each year. 1. Yes 2. No 3. Sometimes 4. Does not apply.

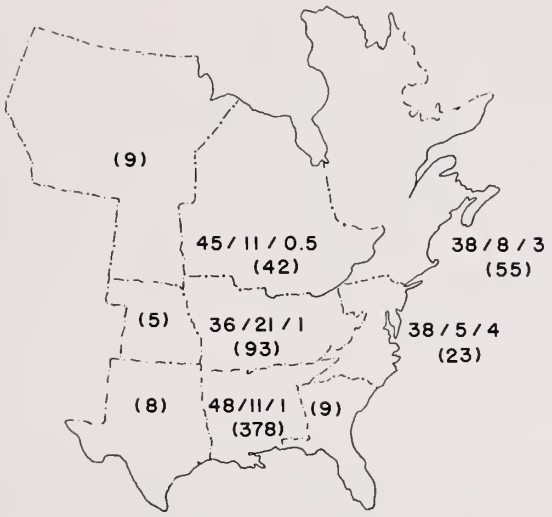

FIG. 1. Arbitrary (and a priori) division of eastern North America into nine sectors for analysis of nest box occupancy. Numbers separated by slashes are the percentages of apartments occupied by Purple Martins, House Sparrows, and Starlings, respectively. Numbers in parentheses indicate the total number of colonies from which data were received.

12. There are bushes or high shrubbery growing at the base of the pole supporting the house. 1. Yes 2. No.

21. This house is approximately (*number*) feet above the ground or water.

Data for colonies using gourds were available from too few colonies to permit meaningful statistical analysis. Rather than asking for the number of individuals using the apartments, on the second questionnaire we asked for the total number of apartments occupied by each species. Because of the small total sample size the data were grouped for analysis into nine geographic regions as indicated in Figure 1. These regions will be referred to in subsequent discussions as the northwest, north-central, northeast, west-central, central, and so on.

Using data from the second questionnaire, we calculated the percentage of apartments in each colony that were occupied by martins, sparrows, and Starlings, and compared variation in these percentages with variation in several physical and biotic parameters. Statistical comparisons of data from both questionnaires were made by using a simple analysis of variance, the sum of squares simultaneous test procedure (STP) (Sokal and Rohlf, 1969:685–687), the test for equality of two percentages discussed by Sokal and Rohlf (1969:607–608), or the method of Brandt and Snedecor (Snedecor, 1956:227–230) for comparison of sets of more than two percentages.

Sample sizes for the various data sets refer to the number of colonies or houses; percentages refer to the number of apartments occupied.

RESULTS

First Questionnaire.—One of the major findings from the first questionnaire was a statement of the relative abundance and distribution of Purple Martins. This information is given in Table 1, expressed as ratios of occupancy for each state or Canadian province from which there were five or more cooperators. In general, the number of martins per apartment is highest in southwestern Ontario along Lake Erie, along the Maine coast, and in the mid-south (Tennessee and Mississippi). The lowest ratios are from parts of the mid-west, middle Atlantic states, and Florida. An analysis of variance indicates that there is significant geographic variation in the use of apartments by martins ($p \leq 0.05$).

TABLE 1

RATIO OF MARTINS/APARTMENT FOR EACH STATE OR CANADIAN PROVINCE REPRESENTED BY DATA FROM FIVE OR MORE COLONIES

State or province	Total number of apartments	Total number of Purple Martins	Ratio: martins/apartment
Ontario	232	363	1.56
Maine	310	360	1.16
Tennessee	314	362	1.15
Mississippi	13133	10797	0.82
Oklahoma	182	133	0.73
Virginia	152	107	0.70
New York	1587	1086	0.68
New Jersey	278	190	0.68
Ohio	237	159	0.67
South Carolina	124	80	0.65
Arkansas	893	561	0.63
Iowa	2592	1620	0.63
Alabama	160	116	0.63
Wisconsin	286	164	0.57
Louisiana	223	121	0.54
Pennsylvania	607	299	0.49
Texas	100	46	0.46
Maryland	217	96	0.44
Illinois	362	151	0.42
Minnesota	418	157	0.38
Nebraska	86	27	0.31
Florida	402	110	0.27
Michigan	174	46	0.26
Connecticut	322	48	0.15

TABLE 2

RATIO OF BIRDS/APARTMENT IN RELATION TO APARTMENT HEIGHT AND VEGETATION WITHIN 15.2 M OF THE APARTMENTS

	Number of colonies	Ratio of birds/apartment		
		Martins	Sparrows	Starlings
Apartment height (m)				
2 < 3	72	0.75	0.20	0.05
3 < 4	202	0.64	0.18	0.01
4 < 5	370	0.67	0.20	0.03
5 < 6	95	0.73	0.23	0.02
6 < 7	125	0.63	0.21	0.03
7 < 8	53	0.73	0.20	0.03
Vegetation				
A few small shrubs	187	0.74	0.15	0.03
One or more small trees	366	0.68	0.20	0.03
One or more large trees	532	0.67	0.20	0.03

From that survey we also found the height of the apartments seems to have little effect on occupancy. Data for apartment height were grouped into six classes (Table 2), among which no significant differences were found in occupancy values for any of the species considered.

On the other hand, the distance of apartments from the nearest building seems to be important to martins, but less so to sparrows or Starlings. There were no significant differences among mean ratios of martins per apartment for distance subsets closer than 30 m from the nearest building. Apartments closer than 30 m, however, had significantly more ($p \leqslant 0.05$) martins (mean = 0.73 martins/apartment) than did apartments that were more than 30 m distant (mean = 0.55 martins/apartment).

Finally no significant differences were indicated in occupancy rates as related to habitat types in the vicinity of the apartments. We did note a trend toward fewer martins and more sparrows ($p \leqslant 0.1$) with increasing height of vegetation (Table 2), although a larger sample size and/or a refinement of the question is needed to statistically confirm the relationships.

The very large body of data from Mississippi makes it possible to compare colonies using gourds, houses, or both. From that state 592 cooperators reported 3,173 gourds and 1,046 houses with a total of 13,133 apartments available for birds. Totals of 10,797 Purple Martins, 1,754 House Sparrows, and 379 Starlings were reported nesting in these apartments. Table 3 summarizes the ratios of martins and sparrows per apartment for the three colony types (Starlings were not analyzed because of their relatively smaller number).

Table 3

Ratio of Martins/Apartment and Sparrows/Apartment in Gourds as Opposed to Houses in Mississippi

Colony type	Number of colonies	Martins/apartment	Sparrows/apartment
Gourds only	73	1.20	0.07
Houses only	352	0.83	0.17
Both houses and gourds	164	0.66	0.18

The three ratios for martins all are significantly different ($p \leqslant 0.01$). The ratio of sparrows/apartment for gourd colonies is significantly less than the ratio for either colonies with houses or colonies with both houses and gourds ($p \leqslant 0.02$).

Comparison of the ratio of martins/apartment in house and gourd colonies in Mississippi with and without sparrows also indicates significant differences ($p \leqslant 0.05$). In colonies with apartment houses and no sparrows there were more martins per apartment (ratio = 1.02, n = 122) than in colonies without sparrows (ratio = 0.79, n = 217). This was also true in colonies with gourds as apartments (no sparrows: ratio = 1.36, n = 49; with sparrows: ratio = 0.98, n = 21). There were also significantly more martins in gourd colonies without sparrows than in house colonies without sparrows. The difference between house and gourd colonies with sparrows was not significant, nor was that between house colonies without sparrows and gourd colonies with sparrows.

Second Questionnaire.—Analysis of data from the second questionnaire provides more insight into the geographic variation in relative population levels and the factors influencing nest-site selection in the three species.

Analysis of the percentages of apartments used by the birds in the nine geographic sectors (Fig. 1) confirms the trends indicated by data from the first questionnaire. STP analysis reveals two non-significant subsets based on the ranked means of percentages of apartments used by martins. Occupancy is higher in the south-central than in the central region, but differences between other pairs of sectors are not statistically significant.

Significant geographic variation is also indicated in the relative use of apartments by sparrows. Two non-significant subsets were defined by STP analysis—the central sector had a significantly higher proportion of sparrows than any other area. There were no significant differences between any pair of the remaining sectors.

Analyses of the types of house (Table 4) showed higher percentage of occupany in wooden than in alumninum houses for all three species; however,

TABLE 4

PERCENTAGE OF APARTMENTS OCCUPIED RELATIVE TO THE PHYSICAL CHARACTERISTICS AND GENERAL LOCATION OF THE HOUSE

	Number of		Percentage of apartments occupied by:		
	Houses	Apartments	Martins	Sparrows	Starlings
Type of house					
Aluminum	224	2946	40.6	11.0	0.3
Wood	394	5379	44.1	12.4	1.8
Exterior color					
White	556	7585	43.9	11.7	1.0
Brown	20	218	28.4	16.1	8.3
Green	28	341	30.8	17.9	2.6
Interior color					
White	295	3798	43.2	10.2	1.0
Brown	282	3886	44.9	13.9	1.6
Apartments clean in spring					
Yes	526	7200	41.9	12.5	0.9
No	43	502	53.4	9.6	3.4
Location					
Urban-business	22	314	57.3	13.4	0.3
Urban-residential	253	3204	45.1	13.1	1.2
Suburban	147	2036	34.6	14.4	1.7
Rural	198	2791	45.1	8.6	1.2
Water within sight					
Yes	295	3920	45.6	10.5	1.4
No	324	4409	40.5	13.1	1.2
Neighboring martin house					
Yes	498	6569	43.9	13.0	1.1
No	121	1748	39.5	8.0	1.8
Utility wires within sight					
Yes	584	7843	42.6	12.0	1.3
No	36	502	47.4	10.4	0.4
Shrubs at base of support pole					
Yes	137	1910	43.2	14.8	1.7
No	481	6401	42.8	11.1	1.1

TABLE 5

PERCENTAGE OF APARTMENTS OCCUPIED IN RELATION TO THE AMOUNT OF TIME A HOUSE IS IN THE SHADE

	Number of		Percentage of apartments occupied by:		
	Houses	Apartments	Martins	Sparrows	Starlings
Time during which the house is shaded					
Never	353	4934	43.5	12.2	1.4
Always	13	182	46.2	9.3	0.0
Only late afternoon	108	1466	45.4	9.4	1.4
Most of the afternoon	10	108	43.5	19.4	0.9
Most of the day	12	150	36.0	24.7	5.3
Only early morning	99	1224	40.1	12.2	0.7
Most of the morning	20	211	32.2	11.4	0.0

the difference approaches significance only for Starlings ($p \leqslant 0.01$). Most houses (92 percent) were painted white: thus, in spite of large differences in the average percent occupancy, sample sizes for brown and green houses are too small to prove the differences are statistically significant. The data do suggest that martins might favor white houses ($p \leqslant 0.2$) while Starlings favor darker ones ($p \leqslant 0.01$). Martins and Starlings showed no clear preference for white or dark (brown or natural wood) interiors in their apartments, but sparrows may prefer ($p \leqslant 0.2$) the darker colors.

Comparison of houses that were cleaned out before the beginning of the

TABLE 6

PERCENTAGE OF APARTMENTS OCCUPIED IN 1971 AS IT RELATES TO THE YEAR IN WHICH A HOUSE WAS FIRST ERECTED

Year house was first erected	Number of		Percentage of apartments occupied by:		
	Houses	Apartments	Martins	Sparrows	Starlings
1971	113	1398	30.0	10.0	1.4
1970	86	1165	43.0	9.7	1.1
1969	90	1125	48.4	11.3	1.3
1968	91	1160	42.5	12.8	1.5
1967	53	677	43.6	15.2	1.9
1966	46	608	50.5	14.8	1.6
1965	40	555	56.6	11.9	0.0
Before 1965	93	1558	41.5	12.9	1.0

TABLE 7

THE PERCENTAGE OF APARTMENTS OCCUPIED IN RELATION TO THE NUMBER OF APARTMENTS/HOUSE

	Number of		Percentage of apartments occupied by:		
	Houses	Apartments	Martins	Sparrows	Starlings
Number of apartments/house					
8 or fewer	122	789	49.9	14.6	1.8
9–12	280	3284	41.9	11.6	0.9
13–16	91	1403	43.6	15.0	1.5
17–20	68	1273	47.8	8.9	2.1
21–24	46	1132	32.8	11.1	0.7
25–28	3	80	52.5	2.5	0.0

breeding season and those that were not suggests that martins might prefer to use an old nest as a base for a new one ($p \leqslant 0.2$). Only 43 cooperators failed to clean out their bird houses.

Analyses of the general location of houses (Table 4) show that suburban colonies had significantly fewer martins ($p \leqslant 0.05$) than did urban-business, urban-residential, or rural colonies. Rural martin houses tended to have fewer sparrows than did either suburban ($p \leqslant 0.1$) or urban-residential colo-

TABLE 8

PERCENTAGE OF APARTMENTS OCCUPIED BY SPECIFIC COMBINATIONS OF MARTINS, SPARROWS, AND STARLINGS

	Number of		Percentage of apartments occupied by:		
Birds Present	Houses	Apartments	Martins	Sparrows	Starlings
No birds	53	769	0.0	0.0	0.0
Martins only	205	2575	57.1	0.0	0.0
Sparrows only	31	382	0.0	20.2	0.0
Starlings only	6	88	0.0	0.0	20.5
Martins and sparrows only	281	3836	48.1	20.4	0.0
Martins and Starlings only	9	164	50.0	0.0	13.4
Sparrows and Starlings only	13	183	0.0	33.9	16.9
Martins, sparrows, and Starlings	24	375	50.1	19.2	9.1

nies. The presence of a pond, lake, or stream within sight of a house may result in a greater occupancy by martins ($p \leqslant 0.2$). Occupancy by sparrows was less, but not significantly so. The occurrence of another house within one-half mile had no significant effect on the percent occupancy by martins, but the increase in the percent occupany by sparrows approaches significance ($p \leqslant 0.15$). The presence of utility wires within sight had no discernible effect on the percent occupancy of a house by any of the species.

The presence of bushes or other high vegetation at the base of the support pole apparently does not influence the rate of occupancy of the house by martins, but may favor occupancy by sparrows ($p \leqslant 0.25$). Statistical comparison of colonies that are in the shade at various times (Table 5) indicates no significant differences for any species, though some trends are suggested. Martins may prefer houses that receive morning sun, and sparrows seem to prefer houses that receive some but not afternoon sun. Larger sample sizes are needed to confirm these patterns.

The percent occupancy by martins for houses erected in 1971 (Table 6) is significantly lower ($p \leqslant 0.05$) than the average percent occupancy for nest boxes erected earlier. No such difference is apparent for sparrows or Starlings. Comparison of occupancy rates in relation to the number of apartments in a house (Table 7) shows no immediate pattern, though the percentage of apartments occupied by martins in houses with eight or fewer apartments is significantly greater than the value for houses with nine to 12 apartments.

Finally, a comparison of houses only occupied by specific combinations of these three species (Table 8) indicates that houses with only martins have significantly more martins than houses that also have sparrows. There were no significant differences within the sets of combinations including sparrows or Starlings.

Discussion

Nest Site Preferences.—Attempts to manage game, aesthetically pleasing, or rare species have multiplied in recent years with the advent of a greater ecological awareness. The Purple Martin, however, is a species that was managed in North America even before the arrival of European man. Indians in the Southeast hung calabash gourds from trees near their villages or from poles in their corn fields. Martins accepted these nest sites and, as a result of their mobbing behavior, kept predators away from the corn and foodstuffs that were hung up to dry (Audubon, 1831; Ewan and Ewan, 1970). The early colonists substituted ceramic jugs and wooden apartment houses for gourds in attempts to attract martins. For example, Audubon (op. cit.) noted that "Almost every country tavern has a martin box on the upper part of its sign-board."

Through the years, martin houses have appeared in as many styles, shapes, and sizes as human dwellings, and a lot of generalities have been made about what will and what won't attract martins. While man has "managed" martins for centuries, the management has been based primarily on tradition, and testing of management practices has been limited to trial and error. One result of our study is that the putative nest site requirements of martins have been objectively analyzed. Such "requirements" have been enumerated many times (e.g., Wade, 1966; Layton, 1969) and generally include such things as: 1. the apartment house should be in an open area at least 8 m from the nearest tree or building; 2. the house should be on a pole 5–10 m above the ground; 3, martins need or prefer utility wires near the house; 4. a pond, lake, or stream nearby is characteristic of a preferred habitat; and 5, the apartments should be cleaned out each year.

Clark (1970) quantitatively examined the relationship between apartment characteristics and rate of occupancy by martins, but, because of her small sample size, her results are inconclusive. Our study confirms some of the suggested requirements, but refutes others. Our data do not support the contention that a martin house should be away from trees or buildings. In fact, houses within 30 m of a building seem to be preferred to those farther away. No clear preferences are shown with regard to apartment height or the presence or absence of utility wires. The contention that martins prefer water nearby is supported.

Most noteworthy is the suggestion that martins prefer apartments that haven't been cleaned out before the beginning of the nesting season. Kinney (1972) notes the use of old nests by Purple Martins, and one of our cooperators reported that the first apartments occupied by martins are always those containing old nests. Boyd (1935) points out that House Martins (*Delichon urbica*) "generally reline and use an old nest," and frequent use of old nests has been observed for the Cliff Swallow (*Petrochelidon pyrrhonota*) (Buss, 1942; Samuel, 1971) and Barn Swallow (*Hirundo rustica*) (Samuel, 1971). The potential energetic savings resulting from use of an old nest is obvious and might be expected to be selected for, though an inherent disadvantage is that old nests harbor parasites that may reduce the fecundity of the birds (Moss and Camin, 1970). From a Purple Martin management point of view we recommend that House Sparrow and Starling nests be removed and that martin nests be left, but dusted with some non-persistent miticide.

It appears that we have been trying to attract martins by following a set of guidelines that for the most part either do not influence the birds or that influence them negatively. Considering this revelation, it would seem appropriate that other management programs, particularly those involving en-

dangered species, be examined for practices that are based on tradition rather than on objective analysis of data.

First Year Occupancy of Houses by Martins.—Mayfield (1964, 1969) in a fifteen-year study of martin houses in Ohio, reported the houses as fully occupied their first year as in subsequent years. However, a reexamination of his data suggests that his sample sizes may have been too small to give statistically valid results. For the first ten years of the study (Mayfield, 1964) 18 of 32 houses had fewer martins the first year than the average for all years. A comparison of this number with the number of houses having the average or a greater number of martins indicates no significant differences ($\chi^2 = 0.50$). With five more years data (Mayfield, 1969) the differences are still not significant (21 houses with fewer than the average number of martins the first year, 15 with the average or more: $\chi^2 = 1.0$), but the increased chi square value and trend of the data suggest that only increased sample size is needed for statistical proof. In our study comparison of a large number of houses for a single year confirms the traditional suggestion that first year houses are likely to attract fewer martins. This may be because houses are frequently placed by inexperienced people on a trial-and-error basis and often moved if unused. Such a difference probably also reflects the tendency for young martins to return to the general area of the colony in which they were hatched and for adults to return to the same colony to nest year after year (Allen and Nice, 1952; Olmstead, 1955).

Competition Among Species for Nest Sites.—The data presented here suggest that Starlings are not a serious threat to the Purple Martin as a nest site competitor (though they may be a serious threat as a predator on nestlings and eggs (Flentge, 1940; Gaunt, 1959)). Kessel (1957) never found more than one pair of Starlings nesting in a multi-apartment house. She states that one male will defend an entire apartment house against other Starlings but that "once settled in his small domain . . . the starling becomes an unobtrusive neighbor" to other species. Finally, as Wade (1966) suggests and this study confirms, aluminum houses which are used widely for martins, further deter the Starling from competing with martins.

House Sparrows, unlike Starlings, will nest communally and therefore present more of a problem for martins. The relative degree to which these species have adapted to communal nesting is perhaps reflected by the average percentage of apartments they occupy in a colony. We found these figures to be 48.1 percent for martins and 20.4 percent for sparrows, and Olmstead (1955) reported similar values (50.0 percent for martins, 18.2 percent for sparrows) for a Kansas colony he studied for five years. With such a high percentage of apartments occupied by sparrows, it is not surprising that the presence of sparrows results in a significant decrease in the number of apart-

ments martins occupy. The effect of sparrows, however, may be more than a proportionate loss of potential martin nest sites. Pindar (1923) suggests that if there are only a few martins at an apartment house they may be completely repelled by sparrows. Furthermore, when there are a large number of martins such that most apartments are occupied, the male House Sparrows are likely to usurp the martins' nests and destroy their eggs (Olmstead, 1955).

Geographic variation in the relative abundance of martins, sparrows, and Starlings may be related to interspecific competition. In the central region of the eastern United States (Fig. 1), martins are at their lowest, sparrows at their highest, and Starlings at a low relative abundance. In the northeast and east-central regions martins are at a low, sparrows at their lowest, and Starlings at their highest levels. In the south-central region martins are at their highest, and sparrows and Starlings are both at low levels. Levels of all three species may be reduced in the northern sections as a result of some competition with Tree Swallows (*Iridoprocne bicolor*), which are known to nest in martin houses (Tate, 1963; observations reported by participants in this study).

Additional limiting factors may contribute to the regional differences in relative abundance of the species. Climate during the breeding season (hence supply of flying insects) is a known limiting factor for martins (Horton, 1903; Tate, 1972). Amount of land under cultivation for grain crops or number of head of granivorous livestock (hence food supply) may limit sparrows. Suggestive of this is the fact that the central region, where sparrows are relatively most numerous, is well defined (Jones, 1972) as the major area of corn and hog production in North America. Time may be the limiting factor for Starlings. Dispersal of the Starling into areas outside the northeast and east-central regions has been since 1926 (Kalmbach, 1928), and insufficient time may have lapsed for breeding populations to build up to levels similar to those in the northeast. If time is the limiting factor, both martin and sparrow populations can be expected to decrease as the Starlings become more established.

FUTURE WORK

The Purple Martin survey has been continued and enlarged since 1971 in order to monitor population fluctuations. It is pure serendipity that in 1972, after population levels had been documented for one year, Purple Martin populations were decimated by Hurricane Agnes (see Tate, 1972). Thus, with knowledge of previous levels, we can quantify the effects of the storm on martins as well as their reestablishment. Other work stemming from the survey will include multivariate analysis of the data sets presented here and

behavioral and ecological studies of nest site selection and interspecific competition. Persons interested in participating in the survey are urged to contact the senior author.

SUMMARY

A public response survey seeking information about Purple Martin, House Sparrow, and Starling populations and nest site characteristics reveals that: 1, significant geographic variation occurs in the rate of occupancy of apartment houses by Purple Martins and House Sparrows; 2, height of apartments has no significant effect on the rate of occupancy by any of the species; 3, apartments farther than 30 m from the nearest building had significantly fewer martins than closer apartments; 4, there may be fewer martins and more sparrows occupying apartments as height of vegetation increases; 5, in Mississippi, martins show a significant preference for and sparrows a significant avoidance of gourds as nest sites; 6, Starlings may avoid aluminum houses; 7, martins may prefer white apartments while Starlings may favor darker ones; 8, martins tend to prefer apartments that have not been cleaned out after a previous occupancy; 9, suburban have significantly fewer martins than do urban or rural colonies and rural tend to have fewer sparrows than do suburban or urban colonies; 10, the presence of a pond, lake or stream within sight of the apartments may result in a greater occupancy by martins; 11, the presence of other apartment houses within one-half mile has no significant effect on occupancy by martins, but may result in a greater occupancy by sparrows; 12, significantly fewer apartments are occupied the first year by martins than in subsequent years; 13, competition between martins and sparrows may result in significantly fewer martins occupying a colony, but the Starling is not a serious nest-site competitor.

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